

Redox Reactions

Mr. Hesham Eltoukhy

Sec. (1) Oxidation and Reduction

Oxidation Number: The number of electrons lost, gained, or shared from an atom of an element to form a bond.

Rules for calculating oxidation numbers

Example

1) The oxidation number of a pure element (uncombined) is zero

Na, Cl_2 , $P_4 = 0$

2) The oxidation number of a monoatomic ion is equal to ion charge

 $Ca^{2+} = +2$, $Br^{-} = -1$

3) The oxidation number of fluorine in its compounds is -1

LiF (F = -1)

4) The oxidation number of oxygen in most of its compounds is -2

 $NO_2 (O = -2)$

5) The oxidation number of hydrogen in most of its compounds is +1

 $H_2CO_3 (H = +1)$

6) The oxidation number of group 1 metals in their compounds is +1

LiBr (Li = +1)

7) The oxidation number of group 2 metals in their compounds is +2

 $MgSO_4 (Mg = +2)$

8) The oxidation number of aluminum in its compounds is +3

 $Al_2O_3 (Al = +3)$

Why is the oxidation number -2 not used for oxygen if the oxidation number of oxygen is to be calculated?

Because oxygen has special cases of oxidation numbers.

Why is the oxidation number +1 not used for hydrogen if the oxidation number of hydrogen is to be calculated?



Because hydrogen has special cases of oxidation numbers.

The oxidation number of Cl, Br, I in their compounds is -1 (if they are the highest electronegativity in the compound or to the right side in the compound)

The sum of the oxidation numbers of neutral compounds is zero.

The sum of the oxidation numbers of a polyatomic ion is equal to the charge of the ion.







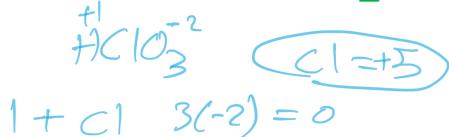


1) What is the oxidation number of the underlined element in: HClO3?









2) What is the oxidation number of the underlined element in: SO_3^{2-} ?

3) What is the oxidation number of the underlined element in: $\underline{As}O_4^{3-}$?

4) What is the oxidation number of the underlined element in: NH₄+?

5) What is the oxidation number of the underlined element in: NaClO₄?

$$a. +7$$





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6)	What is the oxidation number of the underlined element in: <u>Cr</u> ₂ O ₇ ²⁻ ?
	a. +7
	b. +4
	c. +12
	d. +6
7)	What is the oxidation number of the underlined element in: AlPO ₄ ?
	a. +5
	b. +8
	c5
	d. +4
8)	What is the oxidation number of the underlined element in: $Ca_3\underline{N}_2$?
	a. +2
	b3
	c. +3
	d. –2
9)	What is the oxidation number of the underlined element in: $\underline{\mathbf{B}}_{4}\mathbf{O}_{7}^{2-}$?
	a. +1
	b. +6
	c. +3
	d3
10) What is the oxidation number of the underlined element in: KBr?
	a. –1
	h. +1

- c. -2
- d. +2



- 11) What is the oxidation number of the underlined element in: HNO3?
 - a. +5
 - b. +3
 - c. +1
 - d. +2
- 12) What is the oxidation number of the underlined element in: IO_4 ?
 - a. +1
 - b. +5
 - c. +7
 - d. +3
- 13) What is the oxidation number of the underlined element in: $\underline{Mn}O_4$?
 - a. +4
 - b. +3
 - c. +5
 - d. +7
- 14) What is the oxidation number of the underlined element in: **Sb2O5**?
 - a. 0
 - b. +5
 - c. +2
 - d. -5
- 15) What is the oxidation number of the underlined element in: $\underline{W}O_4^{2-}$?
 - a. +8
 - b. +6
 - c. +4
 - d. +2

16) What is the oxidation number of the underlined element in: NH_2 ?

- a. +2
- b. -1
- c. -2
- d. -3

17) What is the oxidation number of the underlined element in: CaCrO₄?

- a. +6
- b. +4
- c. +8
- d. +2

18) What is the oxidation number of the underlined element in: NaHSO4?

- a. +1
- b. +4
- c. +6
- **d.** -6

19) What is the oxidation number of the underlined element in: $Fe(NO_3)_2$?

- a. +5
- b. +2
- c. +3
- d. +4

11	a	12	c	13	d	14	b	15	b
16	d	17	a	18	c	19	a		

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20) Which of the following substances has an oxidation number of nitrogen = +3?
a. NH ₃
b. N_2O_4
c. NO ₃ ⁻
d. NO ₂ ⁻
21) Which of the following substances has an oxidation number of bromine = +5?
a. BrO ₂ -
b. BrO ₃ ⁻
c. BrO ₄ ⁻
d. BrO ⁻
22) Which of the following substances has an oxidation number of oxygen = -1 ?
$\mathbf{a.}~\mathbf{O_2}$
b. H ₂ O
c. OF ₂
d. BaO ₂
23) Which of the following substances has an oxidation number of carbon = 0?
a. $C_2O_4^{2-}$
b. $C_6H_{12}O_6$
c. H ₂ CO ₃
d. CH ₄
24) Which of the following substances has an oxidation number of hydrogen = -1 ?
a. OH⁻
b. HCl
c. H ₂ O



Oxidation and Reduction

Oxidation reaction: A reaction in which a reactant loses electrons.

e with products

Reduction reaction: A reaction in which a reactant gains electrons.

e with reactants

25) Which of the following half-reactions represents an oxidation process?

$$a.~I_2+2e^-\rightarrow~2I^-$$

b.
$$K \rightarrow K^+ + e^-$$

c.
$$Ag^+ + e^- \rightarrow Ag$$

d.
$$Fe^{3+} + e^{-} \rightarrow Fe^{2+}$$

26) Which of the following half-reactions represents a reduction process?

a.
$$2Cl^- \rightarrow Cl_2 + 2e^-$$

b. Na
$$\rightarrow$$
 Na⁺ + e⁻

c. Ca
$$\to$$
 Ca²⁺ + 2e⁻

d.
$$O_2 + 4e^- \rightarrow 2O^{2-}$$

Change in oxidation number

Oxidation reaction: A reaction in which the oxidation number increases.

The oxidation number of the element in the reactants < products

Reduction reaction: A reaction in which the oxidation number decreases.

The oxidation number of the element in the reactants > products

Oxidation-reduction reaction: The reaction in which electrons are transferred from one substance to another.

or

The reaction during which the oxidation number changes.

or

A reaction in which electrons are shared between atoms.





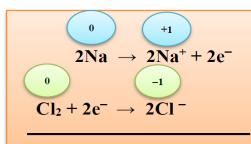


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The union of a substance with oxygen is also one of the definitions of oxidation.

Oxidation and reduction are concomitant processes, (oxidation cannot occur unless reduction also occurs).

number of lost electrons = number of gained electrons



 $2Na + Cl_2 \rightarrow 2Na^+ + 2Cl^-$

oxidation

reduction

Oxidation-reduction

Oxidation-reduction reaction

Why do metals have positive oxidation numbers?

Because the electronegativity of metals is low, they lose electrons.

Why do nonmetals have negative oxidation numbers?

Because the electronegativity of nonmetals is high, they gain electrons.

The light from the party sticks results from a chemical reaction. When the glass capsule is broken inside the plastic tube, a reaction occurs between two chemicals and electrons are transferred, turning the chemical energy into light.



Why are combustion and single replacement reactions a reaction?

Because the oxidation number changes during the reaction.

Why are double replacement reactions not an oxidation-reduction reaction?

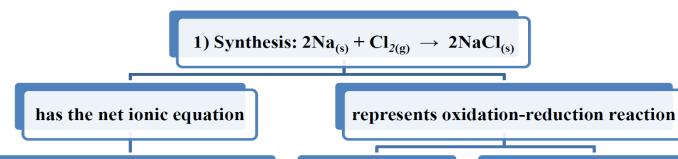
Because the oxidation number does not change during the reaction.

When do synthesis and decomposition reactions represent an oxidation-reduction reaction?

If the oxidation number changes during the reaction.







$$2Na_{(s)} + Cl_{2(g)} \ \to \ 2Na^+ \ + \ 2Cl^-$$

oxidation numbers changes 2 electrons are transferred from the sodium atoms to the chlorine molecule

2) Decomposition:
$$H_2CO_{3(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)}$$

does not represent oxidation-reduction reaction

No transfer of electrons occurs during the reaction

The oxidation numbers of the elements do not change during the reaction

No sharing of electrons occurs during the reaction

3) Combustion:
$$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$$

has the net ionic equation

represents oxidation-reduction reaction

$$2Mg + O_2 \rightarrow 2Mg^{2+} + 2O^{2-}$$

oxidation numbers changes One atom of magnesium gives 2 electrons to each oxygen atom

4) Single replacement:
$$2KBr_{(aq)} + Cl_{2(g)} \rightarrow 2KCl_{(aq)} + Br_{2(aq)}$$

K⁺: spectator ion

has the net ionic equation

represents oxidation-reduction reaction

$$2Br^-_{\;(aq)} + Cl_{2(g)} \; \to \; 2Cl^-_{\;(aq)} + Br_{2(aq)}$$

oxidation numbers changes

2 electrons are transferred from the bromide ion to the chlorine molecule







5) Double replacement: $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

Na⁺, Cl⁻: spectator ions

has the net ionic equation

does not represent oxidation-reduction reaction

$$\mathbf{H^+}_{(aq)} + \mathbf{OH^-}_{(aq)} \rightarrow \mathbf{H_2O}_{(l)}$$

No transfer of electrons occurs

The oxidation numbers does not change

No sharing of electrons occurs

- 27) Why does the oxidation number decrease in a reduction reaction?
 - a. gaining electrons

b. losing electrons

c. addition of OH⁻ ions

- d. addition of H₃O⁺ ions
- 28) In the half-reaction: $Ag^+ + e^- \rightarrow Ag$, why do silver ions change into silver atoms?
 - a. silver ions ionized
 - b. silver ions are oxidized
 - c. silver ions are reduced
 - d. the oxidation number of silver ions does not change
- 29) In an oxidation-reduction reaction, CO turns into CO_2 , how many electrons are lost or gained from C?
 - a. lose one electron
 - b. lose two electrons
 - c. gain one electron
 - d. gain two electrons
- 30) In an oxidation-reduction reaction, MnO₄⁻ turns into MnO₄²⁻, how many electrons are gained or lost from Mn?
 - a. lose one electron

b. lose two electrons

c. gain one electron

d. gain two electrons



31) In the reaction: $2K + Br_2 \rightarrow 2K^+ + 2Br^-$, which species is reduced?

a. K

b. Br₂

c. K⁺

d. Br

32) Which of the following changes represents an oxidation process?

a. $ClO^- \rightarrow Cl^-$

b. $VO^{2+} \rightarrow VO_3^-$

c. $NO_2^- \rightarrow N_2$

d. $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

33) Which of the following changes represents a reduction process?

a. $Fe^{2+} \rightarrow Fe^{3+}$

b. $NH_3 \rightarrow NO_2$

c. $Cr_2O_7^{2-} \to Cr^{3+}$

d. $H_2S \rightarrow SO_4^{2-}$

34) What is the total number of electrons transferred during the balanced reaction?

$$2Na + 2H^+ \rightarrow 2Na^+ + H_2$$
?

- a. a transfer of 2 electrons from Na to H⁺
- b. a transfer of 1 electron from Na to H⁺
- c. a transfer of 2 electrons from H⁺ to Na
- d. a transfer of 1 electron from H⁺ to Na

35) What is the total number of electrons transferred during the balanced reaction?

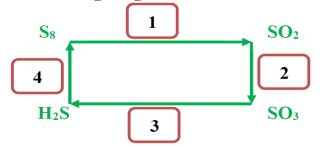
$$2Ce + 3Cu^{2+} \rightarrow 3Cu + 2Ce^{3+}$$

- a. a transfer of 3 electrons from Ce to Cu²⁺
- b. a transfer of 6 electrons from Ce to Cu²⁺
- c. a transfer of 3 electrons from Cu²⁺ to Ce
- d. a transfer of 6 electrons from Cu²⁺ to Ce



36) What step represents the reduction process in the following diagram?

- a. 1
- b. 2
- c. 3
- d. 4



37) Which of the following reactions is an oxidation-reduction reaction?

a. $2HI \rightarrow H_2 + I_2$

- b. $HCl + NaOH \rightarrow NaCl + H_2O$
- c. $CaCO_3 \rightarrow CaO + CO_2$
- d. $AgNO_3 + NaBr \rightarrow NaNO_3 + AgBr$

38) Which of the following reactions is **not** an oxidation-reduction reaction?

a. $N_2 + O_2 \rightarrow 2NO$

b. $H_2O + SO_2 \rightarrow H_2SO_3$

c. $H_2 + Cl_2 \rightarrow 2HCl$

d. $2NaBr + Cl_2 \rightarrow 2NaCl + Br_2$

39) Which of the following statements is **incorrect** for the reaction?

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

- a. the oxidation number of nitrogen changes from -3 to +1
- b. the oxidation number of nitrogen changes from +5 to +1
- c. does not represent an oxidation-reduction reaction
- d. the oxidation number of nitrogen in N_2O is +1

40) Which of the following statements is true for the following redox reaction?

$$ClO_4{}^{\text{-}}{}_{(aq)} + Br{}^{\text{-}}{}_{(aq)} \rightarrow Cl{}^{\text{-}}{}_{(aq)} + Br_{2(l)}$$

- a. the oxidation number of Cl changes from -1 to +4
- b. the oxidation number of Cl changes from -1 to zero
- c. the oxidation number of Br changes from -1 to zero
- d. the oxidation number of Br changes from -1 to 2







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41) Which of the following half-reactions represents a reduction process?

a.
$$H_2S \rightarrow S + 2e^- + 2H^+$$

b.
$$SO_2 + 4e^- + 2H_2O \rightarrow S + 4OH^-$$

c.
$$[Mn(CN)_6]^{4-} \rightarrow [Mn(CN)_6]^{3-} + e^{-}$$

d. Al
$$\rightarrow$$
 Al³⁺ + 3e⁻

42) Which of the following is reduced in the reaction? $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$

a. Al³⁺

b. Al

c. Cu²⁺

d. Cu

43) In an oxidation-reduction reaction, MnO₄⁻ turns into Mn²⁺, how many electrons are lost or gained from Mn?

a. lose 2 electrons

b. lose 5 electrons

c. gain 2 electrons

d. gain 5 electrons

44) How many electrons are transferred in the balanced reaction?

$$2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$$

- a. a transfer of 1 electron from Br to Cl2
- b. a transfer of 2 electrons from Br⁻ to Cl₂
- c. a transfer of 1 electron from Cl₂ to Br
- d. a transfer of 2 electrons from Cl₂ to Br

45) Which of the following statements is true for the oxidation-reduction reaction?

$$2Zn + O_2 \ \rightarrow \ 2ZnO$$

- a. the oxidation number of O changes from 0 to -1
- b. the oxidation number of O changes from -2 to 0
- c. the oxidation number of Zn changes from 0 to +2
- d. the oxidation number of Zn changes from +1 to 0





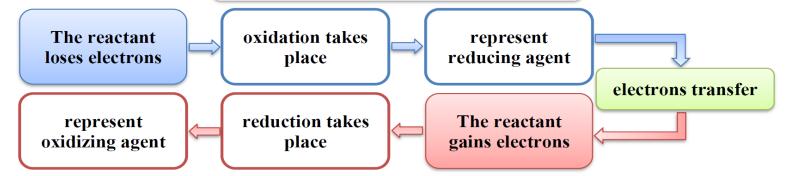
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- 46) What is the spectator ion in the reaction? $MgI_2 + Br_2 \rightarrow MgBr_2 + I_2$
 - a. Mg²⁺
 - $b. I_2$
 - c. Br₂
 - d. Br
- 47) Which of the following changes represents an oxidation reaction?
 - a. $ClO^- \rightarrow Cl^-$
 - b. $CrO_4^{2-} \rightarrow Cr$
 - c. $VO_2^{2-} \rightarrow VO_3^{2-}$
 - d. $NO_2^- \rightarrow N_2$
- 48) Which of the following reactions is **not** an oxidation-reduction reaction?
 - a. $H_2O + CO_2 \rightarrow H_2CO_3$
 - **b.** $N_2 + 2O_2 \rightarrow 2NO_2$
 - c. $H_2 + I_2 \rightarrow 2HI$
 - d. $2NaCl + F_2 \rightarrow 2NaF + Cl_2$
- 49) What is the total change in the oxidation number of chlorine in the following redox $ClO_3^- + 6Fe^{2+} + 6H^+ \rightarrow Cl^- + 6Fe^{3+} + 3H_2O$ reaction?
 - a. -1
 - **b.** -6
 - **c.** 0
 - d. -5

41	b	42	С	43	d	44	b	45	c
46	a	47	c	48	a	49	b		

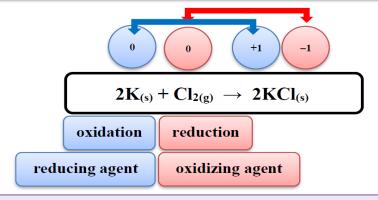


Oxidizing agents and reducing agents



Reducing agent: A substance that reduces another substance by losing electrons.

Oxidizing agent: A substance that oxidizes another substance by gaining electrons.



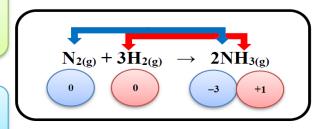
Electrons transfers from the reducing agent to the oxidizing agent.

Using NaClO sodium hypochlorite laundry bleach leads to the oxidation of stains and dyes, as it is an oxidizing agent.

Some redox reactions involve changes in the oxidation number of compounds in which the bonds are covalent.

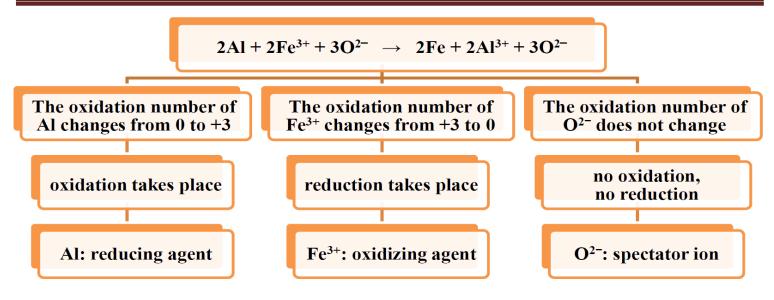
The reaction to form ammonia is an oxidationreduction reaction, even though the reactants and products are molecular compounds?

Because one of the atoms lost electrons(H), and the other atom gained electrons (N).









50) What is the reducing agent, the oxidizing agent in the reaction?

$$Fe + 2Ag^+ \rightarrow Fe^{2+} + 2Ag$$

choice	reducing agent	oxidizing agent
a.	Fe ²⁺	Ag
b.	Ag	Fe ²⁺
c.	Fe	$\mathbf{A}\mathbf{g}^{+}$
d.	$\mathbf{A}\mathbf{g}^{+}$	Fe

- 51) What is the reducing agent in the reaction? $2Fe_{(s)} + 6HBr_{(aq)} \rightarrow 2FeBr_{3(s)} + 3H_{2(g)}$
 - a. H₂
 - b. Fe
 - c. HBr
 - d. FeBr₃
- 52) What is the oxidizing agent in the reaction? $H_2S + Cl_2 \rightarrow S + 2HCl$
 - a. Cl₂
 - b. H₂S
 - c. S
 - d. HCl





- 53) Which of the following statements is true for the reaction? $Mg + I_2 \rightarrow MgI_2$
 - a. the oxidation number of I changes from 0 to -2
 - b. the oxidation number of Mg changes from 0 to +1
 - c. I2 represents spectator ion
 - d. Mg is a reducing agent
- 54) What is the reducing agent in the reaction?

$$8H^{+} + Sn + 6Cl^{-} + 4NO_{3}^{-} \rightarrow SnCl_{6}^{2-} + 4NO_{2} + 4H_{2}O$$

a. H⁺

b. Sn

c. CI

- d. NO₃
- 55) What is the oxidizing agent in the reaction? $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
 - $a. O_2$

b. NH₃

c. H₂O

- d. NO
- 56) Which of the following statements is true for the reaction?

$$Mg + 2Ag^+ \rightarrow Mg^{2+} + 2Ag$$

- a. the oxidation number of Ag increases during the reaction
- b. an oxidation process of Ag+ takes place
- c. Mg represents a stronger oxidizing agent than Ag
- d. Mg is a stronger reducing agent than Ag
- 57) What does oxygen represent when hydrogen peroxide is decomposed?

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

- a. a reducing agent only
- b. an oxidizing agent only
- c. reducing agent and oxidizing agent
- d. does not represent a reducing agent or an oxidizing agent

54 b	55	a	56	d	57	c		
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2021-2022 Exam Questions

- 1. Which of the following is true for the reaction: $2K_{(s)} + F_{2(g)} \rightarrow 2KF_{(s)}$?
 - a. potassium atom, K, has gained an electron and is reduced
 - b. fluorine F₂ gained electrons and oxidized
 - c. potassium atom, K, has lost an electron and has oxidized
 - d. fluorine F2 lost electrons and oxidized
- 2. What is the reducing agent in the following reaction?

$$H_2S_{(g)} + Cl_{2(g)} \rightarrow S_{(s)} + 2HCl_{(g)}$$

- a. S
- b. HCl
- c. H₂S
- d. Cl₂
- 3. What is the correct ascending order of the following formulas according to the oxidation number of chlorine in each?

- a. NaCl \rightarrow Cl₂ \rightarrow KClO \rightarrow KClO₄
- b. $Cl_2 \rightarrow NaCl \rightarrow KClO_4 \rightarrow KClO$
- c. $KClO_4 \rightarrow KClO \rightarrow Cl_2 \rightarrow NaCl$
- d. $KClO_4 \rightarrow NaCl \rightarrow Cl_2 \rightarrow KClO$

1	c	2	c	3	a					
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Sec. (2) Balancing Redox Equations

Balancing Redox Equations using half-reactions method

1) Calculate the oxidation numbers of atoms in the equation.

Using the rules for the oxidation number.

2) Write the half- reactions.

Oxidation half-reaction, half-reduction reaction.

3) Balance each half-reaction individually.

a) Balance the atoms whose oxidation number changes.

By adding coefficients to the elements whose oxidation number has changed.

b) Balance of oxygen.

Add H₂O to balance the difference in oxygen atoms between the two sides.

c) Balance of hydrogen.

Add H⁺ to balance the difference in hydrogen atoms between the two sides.

d) Balance the charge.

Add e⁻ to balance the change in oxidation number of the element in the equation.

4) Equal of charge.

Number of lost electrons = number of gained electrons

5) Get the balanced equation.

Subtract the same types on two different sides, add the same types on the same side.

6) Check the balance.

The number of atoms and the charges on both sides are equal.

Balancing Redox Equations in basic solution

Add the number of OH⁻ equal to the number of H⁺ in the final balanced equation, to get H₂O

$$H^+ + OH^- \rightarrow H_2O$$

x mol

x mol

x mol

The H₂O molecules produced at both ends can be canceled to obtain a balanced equation in a basic solution.







58) What is the balanced equation for the following half-reactions? (in acidic solution)

$$Al \rightarrow Al^{3+} + 3e^{-}$$
 , $IO_4^{-} + 2e^{-} \rightarrow IO_3^{-}$

a.
$$2Al + 3IO_4^- \rightarrow 2Al^{3+} + 3IO_3^-$$

b. Al +
$$IO_4^-$$
 + 6H⁺ \rightarrow Al³⁺ + IO_3^- + 3H₂O

c.
$$2Al + 3IO_4^- + 2H^+ \rightarrow 2Al^{3+} + 3IO_3^- + H_2O$$

d.
$$2Al + 3IO_4^- + 6H^+ \rightarrow 2Al^{3+} + 3IO_3^- + 3H_2O$$

59) What is the balanced equation for the following half-reactions? (in acidic solution)

$$N_2O \rightarrow 2NO_3^- + 8e^-$$
 , $I_2 + 2e^- \rightarrow 2I^-$

a.
$$N_2O + I_2 \rightarrow 2NO_3^- + 2I^-$$

b.
$$N_2O + I_2 + 5H_2O \rightarrow 2NO_3^- + 2I^- + 10H^+$$

c.
$$N_2O + 4I_2 + 5H_2O \rightarrow 2NO_3^- + 8I^- + 10H^+$$

d.
$$N_2O + 5I_2 + 5H_2O \rightarrow 2NO_3^- + 10I^- + 10H^+$$





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60) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$MnO_4^-_{(aq)} + Sn^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + Sn^{4+}_{(aq)}$$

a.
$$5Sn^{2+} + 8H^+ + 2MnO_4^- \rightarrow 5Sn^{4+} + 2Mn^{2+} + 4H_2O$$

b.
$$\text{Sn}^{2+} + 16\text{H}^+ + \text{MnO}_4^- \rightarrow \text{Sn}^{4+} + \text{Mn}^{2+} + 8\text{H}_2\text{O}$$

c.
$$5Sn^{2+} + 16H^+ + 2MnO_4^- \rightarrow 5Sn^{4+} + 2Mn^{2+} + 8H_2O$$

d.
$$2Sn^{2+} + 8H^+ + 5MnO_4^- \rightarrow 2Sn^{4+} + 5Mn^{2+} + 4H_2O$$

61) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$Cr_2O_7^{2-}_{(aq)} + I^{-}_{(aq)} \rightarrow I_{2(s)} + Cr^{3+}_{(aq)}$$

a.
$$Cr_2O_7^{2-} + 2I^- \rightarrow I_2 + 2Cr^{3+}$$

b.
$$Cr_2O_7^{2-} + 3I^- + 7H^+ \rightarrow 3I_2 + 2Cr^{3+} + 7H_2O$$

c.
$$Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 3I_2 + 2Cr^{3+} + 7H_2O$$

d.
$$Cr_2O_7^{2-} + 6I^- + 2H^+ \rightarrow 3I_2 + Cr^{3+} + H_2O$$





62) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$NO_2^- \rightarrow NO + NO_3^-$$

a.
$$3NO_2^- + H^+ \rightarrow 2NO + NO_3^-$$

b.
$$3NO_2^- + 2H^+ \rightarrow 2NO + NO_3^- + H_2O$$

c.
$$2NO_2^- + 2H^+ \rightarrow NO + NO_3^- + H_2O$$

d.
$$3NO_2^- \rightarrow 2NO + NO_3^-$$

63) What is the balanced equation for the following redox equation?

(using half-reactions method, in basic solution)

$$N_2O_{(g)} + ClO^-_{(aq)} \rightarrow NO_2^-_{(aq)} + Cl^-_{(aq)}$$

a.
$$N_2O + 2CIO^- + 2OH^- \rightarrow 2NO_2^- + 2CI^- + H_2O$$

b.
$$N_2O + ClO^- + 2OH^- \rightarrow 2NO_2^- + Cl^- + H_2O$$

c.
$$N_2O + 2CIO^- + H_2O \rightarrow 2NO_2^- + 2CI^- + 2H^+$$

d.
$$N_2O + ClO^- + H_2O \rightarrow 2NO_2^- + Cl^- + 2H^+$$







64) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$S + NO_3^- \rightarrow SO_3 + NO_2$$

a.
$$S + 6NO_3^- + 6H^+ \rightarrow SO_3 + 6NO_2 + 3H_2O$$

b.
$$S + NO_3^- + 6H^+ \rightarrow SO_3 + NO_2 + 3H_2O$$

c.
$$S + 6NO_3^- + 2H^+ \rightarrow SO_3 + 6NO_2 + H_2O$$

d.
$$S + 6NO_3^- \rightarrow SO_3 + 6NO_2$$

65) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$I_2 + MnO_4^- \, \rightarrow \, Mn^{2+} + IO^-$$

a.
$$I_2 + MnO_4^- + H_2O \rightarrow Mn^{2+} + 2IO^- + 2H^+$$

b.
$$5I_2 + 2MnO_4^- + 2H_2O \rightarrow 2Mn^{2+} + 10IO^- + 4H^+$$

c.
$$5I_2 + 2MnO_4^- \rightarrow 2Mn^{2+} + 10IO^-$$

d.
$$I_2 + MnO_4^- \rightarrow Mn^{2+} + 2IO^-$$





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66) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$Br^- + MnO_4^- \rightarrow Mn^{2+} + Br_2$$

a.
$$10Br^{-} + 2MnO_{4}^{-} + 16H^{+} \rightarrow 2Mn^{2+} + 5Br_{2} + 8H_{2}O$$

b.
$$2Br^- + 2MnO_4^- + 8H^+ \rightarrow 2Mn^{2+} + Br_2 + 4H_2O$$

c.
$$2Br^- + MnO_4^- + 16H^+ \rightarrow Mn^{2+} + Br_2 + 8H_2O$$

d.
$$10Br^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 5Br_2 + 4H_2O$$

67) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$ClO_4^- + Br^- \rightarrow Cl^- + Br_2$$

a.
$$ClO_4^- + 4Br^- + 8H^+ \rightarrow Cl^- + 2Br_2 + 4H_2O$$

b.
$$ClO_4^- + 8Br^- + 8H^+ \rightarrow Cl^- + 4Br_2 + 4H_2O$$

c.
$$ClO_4^- + 8Br^- + 2H^+ \rightarrow Cl^- + 4Br_2 + H_2O$$

d.
$$ClO_4^- + 4Br^- + 2H^+ \rightarrow Cl^- + 2Br_2 + H_2O$$



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68) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$Cr_2O_7^{2-}_{(aq)} + NO_2^{-}_{(aq)} \rightarrow Cr^{3+}_{(aq)} + NO_3^{-}_{(aq)}$$

a.
$$Cr_2O_7^{2-} + NO_2^{-} + 4H^+ \rightarrow 2Cr^{3+} + NO_3^{-} + 2H_2O$$

b.
$$Cr_2O_7^{2-} + NO_2^{-} + 8H^+ \rightarrow 2Cr^{3+} + NO_3^{-} + 4H_2O$$

c.
$$Cr_2O_7^{2-} + 3NO_2^{-} + 8H^+ \rightarrow 2Cr^{3+} + 3NO_3^{-} + 4H_2O$$

d.
$$Cr_2O_7^{2-} + 3NO_2^{-} + 4H^+ \rightarrow 2Cr^{3+} + 3NO_3^{-} + 2H_2O$$

69) What is the balanced equation for the following redox equation?

(using half-reactions method, in basic solution)

$$BrO_2 + N_2O_4 \rightarrow BrO_3^- + NO_2^-$$

a.
$$H_2O + 2BrO_2 + N_2O_4 \rightarrow 2BrO_3^- + 2NO_2^- + 2H^+$$

b.
$$2OH^- + 2BrO_2 + N_2O_4 \rightarrow 2BrO_3^- + 2NO_2^- + H_2O$$

c.
$$4OH^- + 2BrO_2 + N_2O_4 \rightarrow 2BrO_3^- + 2NO_2^- + 2H_2O$$

d.
$$2H_2O + 2BrO_2 + N_2O_4 \rightarrow 2BrO_3^- + 2NO_2^- + 4H^+$$





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70) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$S^{2-}_{(g)} + NO_3^{-}_{(aq)} \rightarrow S_{(s)} + NO_{(g)}$$

a.
$$S^{2-} + NO_3^- \rightarrow S + NO$$

b.
$$S^{2-} + 2NO_3^- + 8H^+ \rightarrow S + 2NO + 4H_2O$$

c.
$$3S^{2-} + 2NO_3^- + 8H^+ \rightarrow 3S + 2NO + 4H_2O$$

d.
$$3S^{2-} + NO_3^- + 2H^+ \rightarrow 3S + NO + H_2O$$

71) What is the balanced equation for the following redox equation?

(using half-reactions method, in basic solution)

$$Cr_2O_7{}^{2-} + SO_2 \ \rightarrow \ Cr^{3+} + HSO_4{}^{-}$$

a.
$$4H_2O + Cr_2O_7^{2-} + 3SO_2 \rightarrow 2Cr^{3+} + 3HSO_4^{-} + 5OH^{-}$$

b.
$$2H_2O + Cr_2O_7^{2-} + 3SO_2 \rightarrow 2Cr^{3+} + 3HSO_4^{-} + 2OH^{-}$$

c.
$$3H_2O + Cr_2O_7^{2-} + 3SO_2 \rightarrow 2Cr^{3+} + 3HSO_4^{-} + 3H^+$$

d.
$$H^+ + Cr_2O_7^{2-} + 3SO_2 \rightarrow 2Cr^{3+} + 3HSO_4^- + 3H_2O$$







72) What is the balanced oxidation-reduction equation for the following half-reactions?

$$Fe^{2+} \rightarrow Fe^{3+} + e^{-}, 5e^{-} + MnO_4^{-} \rightarrow Mn^{2+}$$

a.
$$Fe^{2+} + MnO_4^- + 2H^+ \rightarrow Fe^{3+} + Mn^{2+} + H_2O$$

b.
$$5Fe^{2+} + MnO_4^- + 2H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + H_2O$$

c.
$$Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Fe^{3+} + Mn^{2+} + 4H_2O$$

d.
$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

73) What is the balanced equation for the following redox equation?

(using half-reactions method, in acidic solution)

$$MnO_2 + Cl^- \rightarrow Mn^{2+} + Cl_2$$

a.
$$2OH^- + MnO_2 + 2Cl^- \rightarrow Mn^{2+} + Cl_2 + 2H_2O$$

b.
$$8H^+ + MnO_2 + 2Cl^- \rightarrow Mn^{2+} + Cl_2 + 4H_2O$$

c.
$$4H^+ + MnO_2 + 2Cl^- \rightarrow Mn^{2+} + Cl_2 + 2H_2O$$

d.
$$2H_2O + MnO_2 + 2Cl^- \rightarrow Mn^{2+} + Cl_2 + 2OH^-$$





74) In the following half-reaction, $NO_3^- \rightarrow NH_4^+$

how many electrons must be added to balance the charge?

a.
$$NO_3^- + 3e^- \rightarrow NH_4^+$$

b.
$$NO_3^- + 8e^- \rightarrow NH_4^+$$

c.
$$NO_3^- \rightarrow NH_4^+ + 5e^-$$

d.
$$NO_3^- \rightarrow NH_4^+ + 8e^-$$

- 75) What must be added to the oxidation-reduction equation that occurs in an acidic medium in order for it to be balanced?
 - a. H₂O, OH⁻
 - b. H₂O, H⁺
 - c. OH only
 - d. H₂O only
- 76) What is the value of X in the equation for the next half-reaction until the equation is

balanced?
$$MnO_{4^{-}(aq)} + 8H^{+}_{(aq)} + Xe^{-} \rightarrow Mn^{2+}_{(aq)} + 4H_{2}O_{(l)}$$

- a. 5
- b. 1
- c. 2
- d. 10

64	a	65	b	66	a	67	b	68	c
69	b	70	c	71	a	72	d	73	c
74	b	75	b	76	a				





2021-2022 Exam Questions

1. The reaction between nickel and copper (II) chloride shown below, what we describe as redox reactions: $Ni_{(s)} + CuCl_{2(aq)} \rightarrow Cu_{(s)} + NiCl_{2(aq)}$?

	oxidation half-reaction	reduction half-reaction
A	$Ni \rightarrow Ni^{2+} + 2e^{-}$	$Cl_2 \rightarrow 2Cl^- + 2e^-$
В	$Ni \rightarrow Ni^{2+} + e^{-}$	$Cu^+ + e^- \rightarrow Cu$
C	$Ni \rightarrow Ni^{2+} + 2e^{-}$	$\mathbf{C}\mathbf{u}^{2+} + 2\mathbf{e}^{-} \to \mathbf{C}\mathbf{u}$
D	$Cu^+ + e^- \rightarrow Cu$	$Ni \rightarrow Ni^{2+} + 2e^{-}$

a. B

b. D

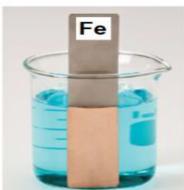
c. A

d. C

2. An iron plate was placed in a copper (II) sulfate solution as shown in the figure below. Why did the iron plate change color?

$$2Fe_{(s)} + 3CuSO_{4(aq)} \rightarrow 3Cu_{(s)} + Fe_2(SO_4)_{3(aq)}$$





a. iron (III) ions are oxidized by losing electrons

b. . reduction of copper (II) ions and copper deposition on the iron plate

c. reduction of iron (III) ions by gaining electrons

d. oxidation of copper atoms to copper (II) ions



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3. Using the half-reaction method to weigh redox reactions, what is the correct balanced equation for the following reaction in an acidic solution?

$$I_{2(s)} + S_2O_3^{2-}_{(aq)} \rightarrow S_2O_4^{2-}_{(aq)} + I^{-}_{(aq)}$$

a.
$$S_2O_3^{2-} + I_2 + 2H^+ \rightarrow S_2O_4^{2-} + H_2O + 2I^-$$

b.
$$S_2O_3^{2-} + H_2O + I_2 \rightarrow S_2O_4^{2-} + 2H^+ + 2I^-$$

c.
$$2S_2O_3^{2-} + 2H_2O + I_2 \rightarrow 2S_2O_4^{2-} + 4H^+ + 2I^-$$

d.
$$S_2O_3^{2-} + H_2O + I_2 \rightarrow S_2O_4^{2-} + 2H^+ + I^-$$

1	d	2	b	3	b		

